

AMENDMENTS TO THE CLAIMS

1. (Currently Amended) A material comprising:

a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a series of increasing structural plurality of structural component size classes, wherein each structural component belonging to an exemplary size class has a characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length;

wherein a said series having a base unit size class has the smallest mean characteristic length of all structural component size classes, and at least one modular size class, wherein a component of said at least one modular size class comprises a plurality of components of the next smaller size class in said series; and

wherein said structural components of said base unit size class comprise at least one bulk phase;

wherein any structural component size class that is not said base unit size class is a modular size class, and wherein a structural component of an exemplary modular size class comprises

- (i) a plurality of structural components of the base unit size class, and
- (ii) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

wherein said structural components are bonded together at interfaces; and

wherein interfaces bonding together structural components of an exemplary modular size class require more energy to propagate mechanical damage than interfaces bonding together originating within a modular size class structural component is energetically favored to propagate in a distributed fashion among said plurality of structural components contained within said modular size class structural componentstructural components of said exemplary modular size class.

2. (Currently Amended) The material of claim 1, wherein a toughness of said interfaces bonding together structural components of an exemplary modular size class have a toughness that structural components (i) is greater than a toughness of said interfaces bonding together said plurality of structural components contained within said modular size class the structural components of said exemplary modular size class, and (ii) is less than and wherein said toughness of said interfaces bonding said modular size class structural components together is less than a toughness of said at least one bulk phase.
3. (Original) The material of claim 1, wherein said interfaces are selected from the group consisting of mechanically interlocked interfaces, chemically bonded interfaces, and combinations thereof.
4. (Original) The material of claim 3, wherein said interfaces bond said structural components in more than one dimension.
5. (Original) The material of claim 4, wherein said interfaces bond said structural components in three dimensions.
6. (Original) The material of claim 3, wherein said interfaces comprise chemically bonded interfaces, and wherein said interfaces comprise at least one interfacial phase.

7. (Currently Amended) The material of claim 6, wherein structural components belonging to a first size class are bonded together by first interfaces, wherein structural components belonging to a second size class are bonded together by second said interfaces, and wherein said first interfaces bonding structural components of a first size class comprise a different material than said second interfaces bonding structural components of a second size class.
8. (Currently Amended) The material of claim 7, wherein structural components of each like size class of structural components in said series is are bonded together by interfaces comprising a material unique to interfaces bonding structural components of said like size class said interfaces bonding said size class.
9. (Original) The material of claim 6, wherein said interfacial phase comprises a material selected from the group consisting of a ceramic, a glass-ceramic, carbon, and mixtures thereof.
10. (Currently Amended) The material of claim 9, wherein said interfacial phase comprises at least one of hexagonal boron nitride, lanthanum phosphate, aluminum oxide (alumina), titanium silicon carbide (Ti₃SiC₂), silica, zirconia, and mixtures and compounds of any of the foregoing materials.
11. (Original) The material of claim 3, wherein said chemically bonded interfaces comprise sintered material.
12. (Original) The material of claim 1, wherein said at least one bulk phase comprises at least one of a ceramic, an organic material, and a metal.
13. (Original) The material of claim 12, wherein said ceramic comprises at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures thereof.

14. (Original) The material of claim 13, wherein said ceramic comprises silicon carbide, titanium carbide, zirconium carbide, hafnium carbide, molybdenum carbide, tantalum carbide, silicon nitride, silicon aluminum oxynitride, aluminum nitride, titanium nitride, titanium diboride, molybdenum disilicide, aluminum oxide, and aluminum silicate.
15. (Original) The material of claim 1, wherein substantially all of said structural components have a substantially similar shape.
16. (Original) The material of claim 15, wherein said shape is characterized by a cross sectional geometry, and wherein said geometry is one of rectangular and circular.
17. (Original) The material of claim 1, wherein said interfaces of said structural components comprise material having a predetermined porosity level.
18. (Original) The material of claim 17, wherein said porosity level varies as a function of said component size class.
19. (Currently Amended) A material comprising:

a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a series of increasing plurality of structural component size classes, wherein each structural component belonging to an exemplary size class has a characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length; wherein a said series having a base unit size class has the smallest mean characteristic length of all structural component size classes, and at least one modular size class, wherein a component of said at least one modular size class comprises a plurality of components of the next smaller size class in said series;

wherein said structural components of said base unit size class comprise at least one bulk phase comprising at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures thereof;

wherein ~~said structural components are bonded together at interfaces~~ are chemically bonded interfaces comprising at least one interfacial phase, said interfacial phase comprising a ceramic, a glass-ceramic, carbon, and mixtures thereof;

wherein any structural component size class that is not said base unit size class is a modular size class, and

wherein a structural component of an exemplary modular size class comprises

- (i) a plurality of structural components of the base unit size class, and
- (ii) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

wherein interfaces bonding together structural components of an exemplary modular size class have a toughness that (i) is greater than a toughness of interfaces bonding together structural components contained within the structural components of said exemplary modular size class, and (ii) is less than a toughness of said at least one bulk phase, a toughness of said interfaces bonding modular size class structural components of a first size class together is greater than a toughness of said interfaces bonding together said plurality of structural components contained within said structural components of said first size class, and wherein said toughness of said interfaces bonding modular size class structural components of said first size class together is less than a toughness of said at least one bulk phase.

20. (Currently Amended) An article comprising:

a material comprising a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a plurality of series of increasing structural component size classes, wherein each structural component belonging to an exemplary size class has a characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length;

wherein a said series having a base unit size class has the smallest mean characteristic length of all structural component size classes, and at least one modular size class, wherein a component of said at least one modular size class comprises a plurality of components of the next smaller size class in said series;

wherein and wherein said structural components of said base unit size class comprise at least one bulk phase;

wherein any structural component size class that is not said base unit size class is a modular size class, and wherein a structural component of an exemplary modular size class comprises

- (iii) a plurality of structural components of the base unit size class, and
- (iv) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

said structural components are bonded together at interlocking interfaces; and

wherein interfaces bonding together structural components of an exemplary modular size class require more energy to propagate mechanical damage than interfaces bonding together originating within a modular size class structural component is energetically favored to propagate in a distributed fashion among said plurality of structural components contained within structural components of said exemplary modular size class said modular size class structural component.

21. (Currently Amended) The article of claim 20, wherein ~~a toughness of said interfaces bonding together structural components of an exemplary modular size class have a toughness that structural components of a first size class together~~ (i) is greater than a toughness of said interfaces bonding together said plurality of structural components contained within said ~~the~~structural components of said ~~first~~said exemplary modular size class, and (ii) is less than

~~and wherein said toughness of said interfaces bonding modular size class structural components of said first size class together is less than a toughness of said at least one bulk phase.~~

22. (Original) The article of claim 21, wherein said interfaces comprise chemically bonded interfaces, and wherein said interfaces comprise at least one interfacial phase.

23. (Original) The article of claim 22, wherein said interfacial phase comprises a material selected from the group consisting of a ceramic, a glass-ceramic, carbon, and mixtures thereof.

24. (Currently Amended) The article of claim 20, wherein said at least one bulk phase comprises at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures and compounds thereof.

25. (Original) The article of claim 20, wherein said article comprises a component of a gas turbine assembly.

26. (Currently Amended) An article comprising:

a material comprising

a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a plurality of series of increasing structural component size classes, wherein each structural component belonging to an exemplary size class has a

characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length;

said series having wherein a base unit size class has the smallest mean characteristic length of all structural component size classes, and at least one modular size class, wherein a component of said at least one modular size class comprises a plurality of components of the next smaller size class in said series; and

wherein said structural components of said base unit size class comprise at least one bulk phase comprising at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures and compounds thereof;

wherein said structural components are bonded together at interfaces are chemically bonded interfaces comprising at least one interfacial phase, said interfacial phase comprising a ceramic, a glass-ceramic, carbon, and mixtures thereof;

wherein any structural component size class that is not said base unit size class is a modular size class, and

wherein a structural component of an exemplary modular size class comprises

- (i) a plurality of structural components of the base unit size class, and
- (ii) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

wherein interfaces bonding together structural components of an exemplary modular size class have a toughness that (i) is greater than a toughness of interfaces bonding together structural components contained within the structural components of said exemplary modular size class, and (ii) is less than a

toughness of said at least one bulk phase, a toughness of said interfaces bonding modular size class structural components of a first size class together is greater than a toughness of said interfaces bonding together said plurality of structural components contained within said structural components of said first size class, and wherein said toughness of said interfaces bonding modular size class structural components of said first size class together is less than a toughness of said at least one bulk phase.

AMENDMENTS TO THE CLAIMS (CLEAN COPY)

1. (Currently Amended) A material comprising:

a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a plurality of structural component size classes, wherein each structural component belonging to an exemplary size class has a characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length;

wherein a base unit size class has the smallest mean characteristic length of all structural component size classes, and

wherein said structural components of said base unit size class comprise at least one bulk phase;

wherein any structural component size class that is not said base unit size class is a modular size class, and wherein a structural component of an exemplary modular size class comprises

- (i) a plurality of structural components of the base unit size class, and
- (ii) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

and

wherein interfaces bonding together structural components of an exemplary modular size class require more energy to propagate mechanical damage than interfaces bonding together structural components contained within structural components of said exemplary modular size class.

2. (Currently Amended) The material of claim 1, wherein interfaces bonding together structural components of an exemplary modular size class have a toughness that (i) is greater than a toughness of interfaces bonding together structural components contained within the structural components of said exemplary modular size class, and (ii) is less than a toughness of said at least one bulk phase.
3. (Original) The material of claim 1, wherein said interfaces are selected from the group consisting of mechanically interlocked interfaces, chemically bonded interfaces, and combinations thereof.
4. (Original) The material of claim 3, wherein said interfaces bond said structural components in more than one dimension.
5. (Original) The material of claim 4, wherein said interfaces bond said structural components in three dimensions.
6. (Original) The material of claim 3, wherein said interfaces comprise chemically bonded interfaces, and wherein said interfaces comprise at least one interfacial phase.
7. (Currently Amended) The material of claim 6, wherein structural components belonging to a first size class are bonded together by first interfaces, wherein structural components belonging to a second size class are bonded together by second interfaces, and wherein said first interfaces comprise a different material than said second interfaces.
8. (Currently Amended) The material of claim 7, wherein structural components of like size class are bonded together by interfaces comprising a material unique to interfaces bonding structural components of said like size class..

9. (Original) The material of claim 6, wherein said interfacial phase comprises a material selected from the group consisting of a ceramic, a glass-ceramic, carbon, and mixtures thereof.
10. (Currently Amended) The material of claim 9, wherein said interfacial phase comprises at least one of hexagonal boron nitride, lanthanum phosphate, aluminum oxide (alumina), titanium silicon carbide (Ti₃SiC₂), silica, zirconia, and mixtures of any of the foregoing materials.
11. (Original) The material of claim 3, wherein said chemically bonded interfaces comprise sintered material.
12. (Original) The material of claim 1, wherein said at least one bulk phase comprises at least one of a ceramic, an organic material, and a metal.
13. (Original) The material of claim 12, wherein said ceramic comprises at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures thereof.
14. (Original) The material of claim 13, wherein said ceramic comprises silicon carbide, titanium carbide, zirconium carbide, hafnium carbide, molybdenum carbide, tantalum carbide, silicon nitride, silicon aluminum oxynitride, aluminum nitride, titanium nitride, titanium diboride, molybdenum disilicide, aluminum oxide, and aluminum silicate.
15. (Original) The material of claim 1, wherein substantially all of said structural components have a substantially similar shape.
16. (Original) The material of claim 15, wherein said shape is characterized by a cross sectional geometry, and wherein said geometry is one of rectangular and circular.
17. (Original) The material of claim 1, wherein said interfaces of said structural components comprise material having a predetermined porosity level.

18. (Original) The material of claim 17, wherein said porosity level varies as a function of said component size class.

19. (Currently Amended) A material comprising:

a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a plurality of structural component size classes, wherein each structural component belonging to an exemplary size class has a characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length; wherein a base unit size class has the smallest mean characteristic length of all structural component size classes, and wherein said structural components of said base unit size class comprise at least one bulk phase comprising at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures thereof;

wherein said interfaces are chemically bonded interfaces comprising at least one interfacial phase, said interfacial phase comprising a ceramic, a glass-ceramic, carbon, and mixtures thereof;

wherein any structural component size class that is not said base unit size class is a modular size class, and

wherein a structural component of an exemplary modular size class comprises

- (i) a plurality of structural components of the base unit size class, and
- (ii) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

wherein interfaces bonding together structural components of an exemplary modular size class have a toughness that (i) is greater than a toughness of

interfaces bonding together structural components contained within the structural components of said exemplary modular size class, and (ii) is less than a toughness of said at least one bulk phase..

20. (Currently Amended) An article comprising:

a material comprising a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a plurality of structural component size classes, wherein each structural component belonging to an exemplary size class has a characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length;

wherein a base unit size class has the smallest mean characteristic length of all structural component size classes, and wherein said structural components of said base unit size class comprise at least one bulk phase;

wherein any structural component size class that is not said base unit size class is a modular size class, and wherein a structural component of an exemplary modular size class comprises

- (iii) a plurality of structural components of the base unit size class, and
- (iv) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

; and

wherein interfaces bonding together structural components of an exemplary modular size class require more energy to propagate mechanical damage than interfaces bonding together structural components contained within structural components of said exemplary modular size class.

21. (Currently Amended) The article of claim 20, wherein interfaces bonding together structural components of an exemplary modular size class have a toughness that (i) is greater than a toughness of interfaces bonding together structural components contained within the structural components of said exemplary modular size class, and (ii) is less than a toughness of said at least one bulk phase.

22. (Original) The article of claim 21, wherein said interfaces comprise chemically bonded interfaces, and wherein said interfaces comprise at least one interfacial phase.

23. (Original) The article of claim 22, wherein said interfacial phase comprises a material selected from the group consisting of a ceramic, a glass-ceramic, carbon, and mixtures thereof.

24. (Currently Amended) The article of claim 20, wherein said at least one bulk phase comprises at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures thereof.

25. (Original) The article of claim 20, wherein said article comprises a component of a gas turbine assembly.

26. (Currently Amended) An article comprising:

a material comprising

a plurality of structural components bonded together at interfaces, each structural component having a characteristic length, said components configured in a plurality of structural component size classes, wherein each structural component belonging to an exemplary size class has a characteristic length that is within 25% of a mean characteristic length calculated for all structural components of the exemplary size class, and wherein each size class has a unique mean characteristic length;

wherein a base unit size class has the smallest mean characteristic length of all structural component size classes, and wherein said structural components of said base unit size class comprise at least one bulk phase comprising at least one of a nitride, an oxide, a carbide, a silicide, a silicate, and mixtures and compounds thereof;

wherein said interfaces are chemically bonded interfaces comprising at least one interfacial phase, said interfacial phase comprising a ceramic, a glass-ceramic, carbon, and mixtures thereof;

wherein any structural component size class that is not said base unit size class is a modular size class, and

wherein a structural component of an exemplary modular size class comprises

- (i) a plurality of structural components of the base unit size class, and
- (ii) a plurality of structural components of modular size classes having mean characteristic lengths less than that of the exemplary modular size class;

wherein interfaces bonding together structural components of an exemplary modular size class have a toughness that (i) is greater than a toughness of interfaces bonding together structural components contained within the structural components of said exemplary modular size class, and (ii) is less than a toughness of said at least one bulk phase..